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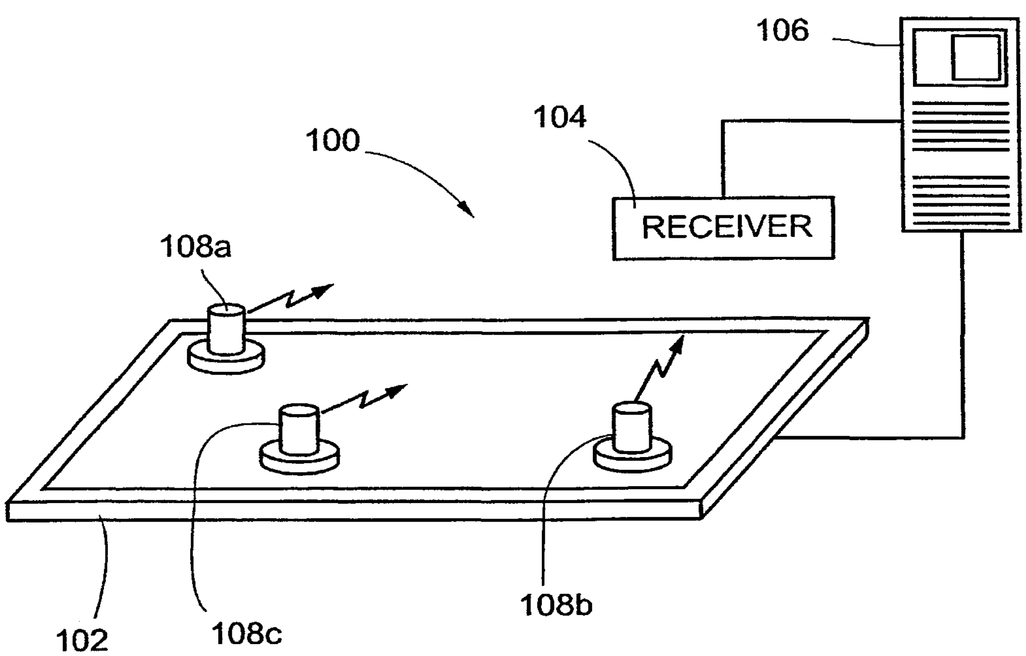
(54) **Title:** SYSTEM AND METHOD FOR DETECTING THE LOCATION OF A PHYSICAL OBJECT PLACED ON A SCREEN



(57) **Abstract:** Method for detecting the location of an object on a display device, comprising the steps of producing a plurality of patterns, each at a selected location on the display device, detecting at least one of the patterns, transmitting a signal indicative of the detected pattern, receiving the transmitted signal, and determining the location of the device, according to the received signal.

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SYSTEM AND METHOD FOR DETECTING THE LOCATION OF A PHYSICAL OBJECT PLACED ON A SCREEN

FIELD OF THE INVENTION

The present invention relates to a system and method for detecting the location of physical objects on a screen in general, and to methods and systems for detecting the location and orientation of physical objects on a screen, in particular.

BACKGROUND OF THE INVENTION

Methods and systems for detecting the location of a physical object on a computer screen are known in the art. These methods conventionally include some wireless triangulation, electromagnetic sensing and the like, between the detected object and a plurality of synchronized receivers, in the vicinity thereof. Other methods include transmitting signals from the object to the screen and detecting this signal in specific areas thereof.

US Patent 5,188,368 to Ryan, entitled "Electronic game apparatus" is directed to an electronic game device, which includes a sensing board and sensible pieces. Each of the sensible pieces is provided with an electrical resonant circuit (i.e. resonator), which is tuned to one of plurality of frequencies, to enable this piece to be distinguished. A plurality of transmit and receive coils are provided beneath the playing surface of the sensing board. Each of resonators in pieces is sensed, due to electromagnetic induction, by the circuits in the board, associated with position "cells". The coupling between the coils in the playing pieces and in the board signals, fed to the board, stimulate the resonators in the pieces. A feedback oscillator, which is initially triggered by the received signal, resonates at a frequency determined by circuit elements in the playing pieces. Induced resonant signal is picked up by the receive coil in the board. Different pieces have different resonant frequencies, such that pieces can be identified based on the frequency of the signal picked up in a given cell on the board. In the Patent '368 the coils are coupled in a configuration which allows sensing of only one cell at a time.

U.S. patent No 5,853,327 to Gilboa, entitled "Computerized game board" is directed to a device combining computer game and board game. The board game includes a game board system, a plurality of toy figures selectably positionable by a player with respect to the game board system, apparatus for automatically and non-discretely sensing the location of the toy figures on the board and actuating an audio/visual display sequence in response thereto. An excitation electromagnetic coil is associated with each cell on the game table. Playing figures, each including an electromagnetic transponder, are located on some of the cells of the game table. A plurality of excitation coils generates query signals, which are received by the transponders of all playing figures located on cells of the game table. The transponder in the playing figure generates a coded answer signal, having a frequency unique to the figure. This signal is received by an antenna, which generates a sensor signal responsive to the answer signal. A plurality of cells are excited by row and column, wherein each excitation coil is connected to a given row and a given column. All of the rows and all of the columns are scanned. If a given figure generates a unique frequency, that frequency will be detected only for the row and column on which the figure is located. In this way, by determining the row and column, which provide the response associated with the figure, the location of the figure is determined. In addition, a plurality of transponders in each of the figures and a plurality of sub-coils, associated with each of the cells is incorporated. This enables to determine the orientation and direction of movement of each of the figures and to actuate an audio/visual display sequence in response thereto.

SUMMARY OF THE PRESENT INVENTION

It is an object of the present invention to provide a novel method and system for detecting the location and orientation of physical objects on a screen, which overcomes the disadvantages of the prior art.

In accordance with the present invention, there is thus provided a method for detecting the location of a device over a display device. The method includes the steps of producing a plurality of patterns, each at a selected location over the display device, detecting at least one of the patterns, transmitting a signal, respective of the detected pattern, receiving the transmitted signal, and determining the location of the device, according to the received signal.

According to one aspect of the invention, the location is determined according to the coincidence of the steps of producing and receiving. The signal can include information respective of the status of selected attributes of the device.

The method can further include the step of generating the signal, after the step of detecting the patterns. The signal can be generated according to the detected pattern. The signal can include a pulse. The signal can include a unique identification code. The signal can include information embedded in the detected pattern.

Each of the patterns can include a unique identification code embedded therein. Accordingly, the method can further include the step of detecting the unique identification code.

According to another aspect of the invention, the step of producing the plurality of patterns, can be performed by scanning the screen with the patterns. The scanning can include a plurality of scanning cycles, wherein each scanning cycle include a plurality of pattern production cycles, which substantially cover the screen. According to a further aspect of the invention, the time period between the step of generating and the step of receiving is significantly small, with respect to the time period between each consecutive pattern production cycles.

The patterns can be displayed on a specific location over the screen, wherein each of the patterns includes a location code embedded therein. The location code is respective of the specific location. Accordingly, the method can further include a step of extracting the location code, after the step of detecting the patterns. Alternatively, the method can further include a step of extracting the location code, after the step of detecting the patterns.

The method can further include a step of receiving instructions from a user, respective of the state of the device. Furthermore, the method can further include a step of producing human detectable signal, after the step of detecting the patterns. The human detectable signal can be selected from the list consisting of a sound, a visible pattern, a tactile event, an odder event, and the like. The mechanical event can include moving the device.

The pattern can include at least one command embedded therein, for operating a unit within the device.

The method can further include the steps of illuminating a portion of the screen by high intensity light (where the portion is located underneath the device), converting the high intensity light into electrical energy, and storing the electrical energy in the power unit of the device.

The step of transmitting is preferably performed wirelessly. The wireless media used in the step of transmitting is selected from the list consisting of radio frequency wireless media, ultrasound wireless media, infrared wireless media, and the like.

In accordance with a further aspect of the invention, there is thus provided a system for determining the location of at least one object device on a display device. The system includes a receiver, for receiving wireless signals from the object devices, a processor, connected to the receiver, and a display interface, connected between the processor and the display device. The processor provides pattern display commands to the display device via the display interface. The wireless signals are respectively of the patterns. The system further includes a plurality of object devices, which are placed on the screen. It is noted that the screen can be horizontal or vertical, such as a white board.

Each of the object devices can include at least one optical detector, facing the screen, a digital logic unit, connected to the optical detectors, and a wireless transmitter connected to the digital logic unit. The optical detectors detect at least one pattern, produced by the display device. The digital logic unit produces a signal, respective of the detected pattern. The wireless transmitter transmits a wireless signal.

The pattern can include at least one light signal sequence. Alternatively, the pattern can include a pixel combination. The optical detector substantially includes a photoelectric detector or an array of photoelectric detectors, such as a charge coupled device (CCD).

The wireless transmitter can be selected from the list consisting of a radio-frequency (RF) transmitter, an infrared transmitter, an ultrasound transmitter, and the like.

The digital logic unit can include a controller and at least one sequence detector, connected to the controller, wherein each of the sequence detectors is connected to a selected one of the optical detectors. Each one of the sequence detectors detects a

predetermined sequence and provides a respective indication to the controller. In turn, the controller produces the signal according to the indication.

According to one embodiment of the invention, the sequence detector is operative to detect a predetermined sequence.

The controller can extract information embedded in the detected pattern. The detected sequence can include an identification code embedded therein. The unique identification code can be associated with the device. The detected sequence can include location information, where the location information is related to the location on the screen on which the sequence is produced. The signal can include a representation of the detected location information.

The device can further include a user interface, connected to the digital logic unit. The user interface can include elements, which are selected from the list consisting of a mechanical input unit, a sound detection unit, a sound production unit, a visual output unit, and the like.

The device can further include a rechargeable power unit, connected to the digital logic unit and to the at least one of the optical detectors. The optical detector converts detected light into electricity, thereby charging the rechargeable power unit.

The device can further include at least one motor, connected to the digital logic unit, for moving the device.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Figure 1 is an illustration of an interactive display system, constructed and operative in accordance with a preferred embodiment of the present invention;

Figure 2 is an illustration in detail of an object device according to the system of Figure 1, constructed and operative in accordance with another preferred embodiment of the present invention;

Figure 3 is an illustration of the screen and the object devices of Figures 1 and 2;

Figure 4A is an illustration of the screen and object device of Figures 1 and 2, with a predetermined light pattern, in accordance with a further preferred embodiment of the present invention;

Figure 4B is a presentation in time of three patterns, as sequences, in accordance with another preferred embodiment of the present invention;

Figure 5 is a schematic illustration of a method for operating the system of Figure 1, operative in accordance with another preferred embodiment of the present invention;

Figure 6 is a schematic illustration of a method for operating the system of Figure 1, operative in accordance with a further preferred embodiment of the present invention;

Figure 7A is an illustration of an object device, constructed and operative in accordance with another preferred embodiment of the present invention;

Figure 7B is a schematic illustration in detail of the object device of Figure 7A;

Figure 8 is an illustration in perspective of an object device, constructed and operative in accordance with a further preferred embodiment of the present invention;

Figure 9 is an illustration of a method for operating the system 100 of Figure 1, with the object device of Figure 8, operative in accordance with another preferred embodiment of the present invention;

Figure 10A is an illustration of an object device of Figure 2, a screen, and a plurality of circular patterns produced thereon, operative in accordance with another preferred embodiment of the present invention;

Figure 10B is an illustration of the object device of Figure 2, and the screen of Figure 10B, at a later stage of the pattern production;

Figure 11A is a schematic illustration of an object device and a screen, on which patterns are presented in accordance with another preferred embodiment of the present invention;

Figures 11B, 11C and 11D, provide illustrations of the object device and the screen of Figure 11A, at later stages of the scanning procedure;

Figure 12 is a schematic illustration of a method for operating the device of Figure 8, operative in accordance with a further preferred embodiment of the present invention; and

Figure 13 is a schematic illustration of a system, constructed and operative in accordance with another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The applications, which are addressed by the present invention, include a screen on which physical objects are placed. An application image is projected (or generated) on the screen and the objects are normally placed on the screen, usually, on specific areas of the application image with respect to their current status in the application. In general, any application can be applied to the platform, such as games, presentations, sports and theater instructing applications, land and air traffic scenarios display and simulation applications, electronic sand tables, and the like. For example, games which can be played on this platform include monopoly, strategic games, educational games and the like.

The present invention overcomes the disadvantages of the prior art by providing a method in which predetermined light patterns are produced on the screen. These images are detected in at least one of many ways by the physical objects and a respective signal is wirelessly transmitted to a receiver, connected to the control module of the application.

Reference is now made to Figure 1, which is an illustration of an interactive display system, generally referenced 100, constructed and operative in accordance with a preferred embodiment of the present invention. System 100 includes a screen 102, a receiver 104, a host computer 106 and a plurality of physical object devices 108A, 108B and 108C. Computer 106 is connected to receiver 104 and to screen 102. Object devices 108A, 108B and 108C are placed over the screen 102.

Reference is further made to Figure 2, which is an illustration in detail of object device 108A, constructed and operative in accordance with another preferred embodiment of the present invention. Object device 108A includes an optical detector 116, a digital logic unit 112, a wireless transmitter 110 and a housing 118. Digital logic unit 112 is connected to detector 116 and to the transmitter 110. Detector 116 is located at the bottom of the housing 118, facing down, so as to detect visible or invisible light signaling patterns which are provided by a screen, over which the object is placed. Transmitter 110 is an RF wireless transmitter. It is noted that transmitter 110 can be replaced with e.g. an infrared wireless transmitter or an ultra-sound wireless transmitter or any other suitable transmitter.

Reference is further made to Figure 3, which is an illustration of screen 102 and object devices 108A, 108B and 108C of Figures 1 and 2. Display 102 produces an image 120. In the example presented in Figure 3, image 120 includes a map of the world. Each of object devices 108A, 108B and 108C is placed over a specific area within image 120. Object device 108A is placed over North America, object device 108C is placed over Africa and object device 108B is placed over Asia.

Reference is further made to Figures 4A and 4B. Figure 4A is an illustration of screen 102 and object device 108A of Figures 1 and 2, with a predetermined light pattern, in accordance with a further preferred embodiment of the present invention. Figure 4B is a presentation in time of three patterns, as sequences, generally referenced 130A, 130B and 130C, in accordance with another preferred embodiment of the present invention.

Screen 102 further produces a light pattern 122 at a plurality of locations. In the present example, the screen 102 produces a moving pattern, which moves in a scanning manner all over the screen. The path of the pattern covers the entire screen so that it will be "intercepted" by any of the object devices, which are placed on the screen. In the present example, object device 108A is able to detect the pattern 122 as it is produced thereunder.

With reference to Figure 4B, sequences 130A, 130B and 130C indicate the activity of a selected pixel over time, where adjacent pixels are activated in the same sequence, but at different times. It is noted that the sequence of activating different pixels of the screen does not necessarily have to be in a predetermined order, rather it can be random.

Referring back to Figure 2, detector 116 detects the pattern 122, produces a respective signal and provides it to the digital logic unit 112. The digital logic unit performs operations on the received signal, produces a trigger or a code, and provides it to transmitter 110. Upon triggering, the transmitter 110 transmits a signal, wirelessly to the receiver 104 (Figure 1). Receiver 104 provides the received signal to host computer 106, which in turn determines the location of object device 108A over screen 102.

A plurality of methods are provided in accordance with the present invention, which can be used to generate a pattern and determine the location of the receiving object device therefrom.

Reference is now made to Figure 5, which is a schematic illustration of a method for operating the system of Figure 1, operative in accordance with another preferred embodiment of the present invention.

In step 150, the surface display is scanned with a predetermined time sequenced pattern. This pattern is respective of a predetermined identification code, which is associated with a selected object. It is noted that this pattern can be produced either on a single pixel at a time, or at a plurality of pixels, adjacent to each other, or scattered over the surface.

The scanning process induces the pattern to be produced at a different predetermined pixel P_i over the surface of the display at a time t_i, where $P_i=P(t_i)$. The result looks like a blinking dot, traveling over the display surface, where the dot blinks at a repeating sequence. Examples for such a sequence is provided in the above Figure 4B.

The blinking dot pattern is detected by a detector of a physical object (step 152) such as detector 116 (Figure 2), which in turn provides an electric representation of the detected pattern to the digital logic unit connected thereto.

In step 154, a compatibility is determined between the internal identification code of the object and the identification code, which is embedded in the detected pattern. When the digital logic unit determines such compatibility, it produces a signal, which is then wirelessly transmitted (step 156) by transmitter 110, to a receiver. It is noted that the transmitted signal can either be un-modulated (such as a single pulse) or modulated, containing additional information, such as the status of the object or other attributes. The receiver 104 (Figure 1) receives the transmitted signal (step 158).

It is noted that the operations of detection of the pattern and transmission of the signal, are substantially performed in real-time (i.e., the time period Δt between detection of the pattern and transmission of the signal is significantly short, compared with the scan time of the display screen. In any case, this time period Δt is substantially predetermined and infinitesimal).

In step 158, the signal is received, and a respective indication is provided accordingly. With respect to Figure 1, the receiver 104 provides an indication to the host computer, upon reception of the transmitted signal. In step 160, the location of the detecting object is determined from the coinciding events of production of the pattern at

a specific location of the screen, by the host computer, and the reception of the signal, by the same host computer.

The transmitted signal is received at a time $t_{RECEIVED}$. Since Δt is substantially constant, then t_i can be determined from t_R where $t_i=t_{RECEIVED}-\Delta t$. Hence the pixel P_I, which was detected by the transmitting object (positioned thereon) is $P_i=P(t_{RECEIVED}-\Delta t)=P(t_i)$. It is noted that when the time interval between each successive progression operations in a scan cycle, is longer than Δt, then the reception of the transmitted signal indicates that the detecting object is located where the pattern was last produced.

The production of light patterns is now repeated with respect to the identification codes of the rest of the objects, which are assumed to be placed on the screen 102 (step 162). After scanning the screen with all of the potential patterns, the system 100 repeats the scanning process from the beginning, for each of the objects.

Reference is now made to Figure 6, which is a schematic illustration of a method for operating the system of Figure 1, operative in accordance with a further preferred embodiment of the present invention.

According to this method, the surface of the display is scanned with a single predetermined light sequenced pattern. Any object, which detects the light sequenced pattern, as it passes thereunder, transmits a wireless signal, embedding a unique identification thereof. The host system, receiving these wireless signals, determines the identity of the transmitting object from the identification code, embedded therein. The host system further determines the location of the transmitting object from the coinciding events of production of the light pattern on a selected location over the screen and the reception of the wireless signal.

In step 170, the screen surface is scanned with a predetermined time sequenced pattern, such as presented in Figure 4B. With respect to the example, provided in Figure 1, the host computer 106 produces display commands for generating a time sequenced pattern at different locations all over screen 102, which eventually scans the entire screen.

In step 172, the pattern is detected by at least one object. The detecting object detects the time-sequenced pattern, by comparing each detected sequence with an internal predetermined sequence, which is identical for all of the objects.

In step 174, the detecting object generates a signal, which embeds a unique identification code thereof and transmits it to a receiver (step 176). It is noted that each of the objects can thus be uniquely identified by its respective identification code, which is extractable from the received signal (step 180.

In step 182, the location of the detecting object is determined from the coinciding events of production of the detected pattern at a specific location on the screen and the reception of the signal.

Reference is further made to Figures 7A and 7B. Figure 7A is an illustration of an object device, generally referenced 200, constructed and operative in accordance with another preferred embodiment of the present invention. Figure 7B is a schematic illustration in detail of object device 200 of Figure 7A.

Object device 200 includes two optical detectors 202A and 202B, a digital logic unit 204, a transmitter 206, a housing 210 and a human interface 208, which includes two indicating light sources 208A and 208B. Digital logic unit 204 includes two sequence detectors 214A and 214B and a controller 216. Sequence detector 214A is connected between light detector 202A and controller 216. Sequence detector 214B is connected between light detector 202B and controller 216. Controller 216 is further connected to transmitter 206 and to human interface 208. Each of sequence detectors 214A and 214B is operative to detect a predetermined unique code, which is associated therewith.

Detectors 202A and 202B are located at different locations at the bottom of housing 210, facing down, so as to enable them to detect light signals provided by a screen facing up, on which they are placed. According to the example, presented in figures 7A and 7B, each of the interconnected light detector - sequence detector pairs, is operative to receive and detect a predetermined pattern and provide an indication of such detection to the controller.

It is noted that each of these two patterns can either be identical, as in the method presented in Figure 6, or unique, with respect to each of the detectors of the same object, similar to the method presented in Figure 5. Accordingly, the signal produced by the controller 216 either includes a simple pulse or an embedded identification code, respective of the detecting detector. Hence, the orientation of the object device 200 can be determined from the locations of each of the detectors thereof.

As stated above, object device 200 includes a human interface 208, which includes two light sources 208A and 208B. Light sources 208A and 208B provide multi-wavelength indication to the user of the device object 200, with respect to various states of the device or other aspects of the associated application. These indications can be provided internally by the controller 216 or be received from the host computer, running the application, via specific pattern detection process, which is associated therewith.

Reference is now made to Figure 8, which is an illustration in perspective of an object device, generally referenced 250, constructed and operative in accordance with a further preferred embodiment of the present invention. Device 250 includes a detector array 254, a plurality of motors 256A, 256B, 256C and 256D, a processor 252, a power unit 262, a speaker 258, a transmitter 260, a user input unit 266, and a housing 264.

Processor 252 is connected to motors 256A, 256B, 256C and 256D, power unit 262, speaker 258, user-input unit 266, transmitter 260 and detector array 254. Detector array 254 is located at the bottom of housing 264, facing downward. Detector array 254 is operative to detect complex patterns, which have high-resolution shapes and high volume patterns. Such a pattern can include a plurality of pixels, where each of them blinks in a different sequence. Furthermore, the angle at which the pattern is detected on the detector array 254, serves to determine the orientation of the object device 250.

User input unit 266 includes four user operated push buttons, which are used to receive instructions from a user. It is noted that each of such buttons can be associated with an integrated visual display unit, which visually indicate the logical state of that push button. For example, push button 266A can be used to receive confirmation from a user, acknowledging a newly set state of the object device. User input unit 266 can be used to receive choices from the user such as selecting between options. For example, a question in a Monopoly game "would you like to buy this estate ?", where pushing button 266B means "YES" and pushing button 266C means "NO".

Processor 252 provides commands to motors 256A, 256B, 256C and 256D, to turn in various directions at different speeds, thereby moving device 250 on the screen. The movement commands can be provided from the controlling host computer, producing respective command patterns at the location where the device was last detected.

The processor 252 also provides audio signals to the speaker 258, which in turn produces respective sounds. It is noted that the commands to produce these sounds can also be initially provided by the host computer, via respective patterns.

Reference is now made to Figure 9, which is an illustration of a method for operating system 100 of Figures 1 and 2, with object device 250 of Figure 8, operative in accordance with another preferred embodiment of the present invention.

In step 300, a plurality of predetermined light patterns are produced on the screen. Each of the light patterns is produced on and in association with a predetermined location on the displaying screen. The pattern is indicative of, and can be regarded as an X-Y representation of the screen location, on which it is displayed. Each of the patterns can be detected by any object device, which is placed on the screen at a location where the pattern is produced (step 302).

In the example set forth in Figures 1 and 8, host computer 106 provides commands to screen 102 to produce pattern 122, where a plurality of location specific patterns are produced at the same time, all over the screen 102. The patterns can be space oriented (various shapes), time oriented (various sequences), or both. The device 250 detects the pattern, and its processor 252 extracts the embedded location information therefrom. It is noted that in accordance with another aspect of the present invention, the plurality of location specific patterns can be produced at different times.

In step 304, a signal is generated in accordance with the detected pattern. The signal embeds a representation of the location as extracted from the detected pattern, together with an identification code of the receiving object device. With respect to Figure 8, processor 252 produces a signal, which embeds the identification code thereof, and representation of the location as extracted from the detected pattern. The processor 252 provides this signal to the transmitter 260, which is turn wirelessly transmits it to the receiver (step 306).

In step 308, the transmitted signal is received by a receiver and the embedded location information and transmitting device identification code are extracted therefrom (step 310). The extracted data determines the location of the detecting device (step 312).

According to a further embodiment of the invention, the power unit of the object device can be charged by the screen, on which it is placed. As the system detects the location of an object device, it illuminates the area on which it is placed, with high

intensity light. It is noted that this light is not visible to the user, since the object covers this entire area. According to this aspect, at least a portion of the cells of detector array 254 are photocells, which convert light into electricity, thereby providing power to charge power unit 262. Hence, power unit 262 need not be replaced and housing 264 can be sealed with respect to this aspect, thereby reducing manufacturing cost and simplifying its structure.

According to another embodiment of the present invention, a “scanning” of the screen by producing patterns in various places thereon, can be achieved in a plurality of ways. Reference is now made to Figures 10A and 10B. Figure 10A is an illustration of object device 108A of Figure 2, a screen, generally referenced 350, and a plurality of circular patterns produced thereon, operative in accordance with another preferred embodiment of the present invention. Figure 9B is an illustration of object device 108A of Figure 2, and screen 350 of Figure 9B, at a later stage of the pattern production.

Figures 10A and 10B provide a polar like approach, where at first, patterns are produced on predetermined circles, each at a different diameter from the inside out and vice-versa. With reference to Figure 10A such circular ring patterns are presented by references 352, 354 and 356. At the first stage, the device 108A is detected on ring 354. At the second stage, represented in Figure 10B, the system “scans” the ring 354 with a small pattern, generally referenced 358, until the device 108A is detected. This ring-like scanning method is useful in applications where there is a high probability that the object would be moved to a new location, which is in the vicinity of its last location. In such a case, the last detected location defines the center of the rings.

Reference is now made to Figures 11A, 11B, 11C and 11D. Figure 11A is a schematic illustration of an object device, generally referenced 372, a screen, generally referenced 370, on which patterns are presented in accordance with another preferred embodiment of the present invention. Figures 11B, 11C and 11D, provide illustrations of the object device and the screen of Figure 11A, at later stages of the scanning procedure.

With reference to Figure 11A, the screen 370 is divided in two (references 374 and 376). A pattern is then produced on the left half 376 thereof. If the object device is located on the left half, then a respective transmission will be received therefrom. Otherwise, when no transmission is received within a predetermined period of time, then

the system can determine that the object device 372 is not placed on the left half 376, and can further search for it on the right half 374.

In the present example, the device 372 provides a transmission. The system in turn divides the left half 376 of the screen 370, in two (references 378 and 380), and produces a pattern on one of them. The procedure is similar. If the device 372 responds, then it is located on the half on which the pattern was produced. Otherwise, it is possible that it is located on the other half. Accordingly, further stages of dividing a selected area in two, producing a pattern on one of the halves, and selecting one of them according to the response (or no response) of the object device, are presented in Figures 11C and 11D, with respect to numerals 382, 384, 386 and 388.

Reference is now made to Figure 12, which is a schematic illustration of a method for operating device 250 of Figure 8, operative in accordance with a further preferred embodiment of the present invention.

In step 350, the surface of a display device is scanned with a plurality of predetermined patterns. Each of the patterns embed information which is respective of a predetermined identical code, a unique identification code respective of a selected object, a representation of the intermediate location on which it is displayed, a combination of the above, and the like. The patterns can be space oriented (various shapes), time oriented (various sequences) or both, where selected pixels of a pattern blink, each at a different predetermined sequence.

It is noted that the scanning operation can be performed in a plurality of ways. When the patterns include the respective location information, then all of the patterns can be produced at once, all over the screen. Alternatively, the patterns can either be produced one at a time or in groups, at selected locations over the display device.

In step 352, at least some of the patterns are detected by a detector of an object placed on the display device, one at a time. The data embedded in the detected pattern is then extracted (step 354).

In step 356, the detecting object generates a signal, according to the extracted data. It is noted that the nature of the data determines the respective nature of the signal. When the extracted data includes the unique identification code of the detecting object, then the signal can include a simple pulse. When the extracted data includes a

representation of the location on which it is displayed, then the signal can include a respective representation of the same location, and in addition, the identification code of the detecting object. When the extracted data includes a universal code, then the signal can include the unique identification code of the detecting object. The signal is then wirelessly transmitted (step 358) by the transmitter of the detecting object. It is noted that any wireless technology is applicable for the present invention, such as RF, infrared and ultrasound, in any of a plurality of formats such as pulse, analog modulation, digital modulation, and the like.

The wireless signal is then received by a receiver (step 360). The signal is demodulated and the data embedded in the received signal is extracted therefrom and used to determine the location, orientation, attributes and other status parameters of the respective detector of the detecting object (step 362). The location and orientation determination procedure can be performed either directly, when the location information is embedded therein, or from the coinciding events of producing the detected pattern and receiving the signal which was generated in turn.

It is noted that when the detector of the respective object includes a detector array, then the angle at which a space oriented pattern is detected thereby, can also be determined by its processor and used to deduce the orientation of the object.

In step 364, the process is repeated for each of the objects, which are placed on the display screen and again to detect any changes in locations of the objects. With respect to another embodiment of the invention, patterns, which address already detected objects, are initially produced in the vicinity of the location in which the object was recently detected.

It is noted that the receiver, host computer and screen, which are illustrated in Figure 1, can be replaced with an integrated system, which is designed specifically for a selected implementation of the present invention. Reference is now made to Figure 13, which is a schematic illustration of a system, generally referenced 400, constructed and operative in accordance with another preferred embodiment of the present invention. System 400 includes a wireless receiver 402, a demodulator 404, a processor 406, a storage unit 408, a display interface 410, and a display device 412. Receiver 402 is a wireless receiver, operative to detect wireless transmissions either in RF, infrared or ultrasound. Demodulator 404 is operative to extract any information which is embedded

in signals which are received by receiver 402, with respect to the format in which there were modulated, such as AM, FM, TDMA, CDMA, and the like. Processor 406 can either include a simple controller or a powerful CPU, with respect to the implementation selected for system 400. Storage unit 408 can include any of a plurality of storage units, operating, for example according to optical storage technologies, electromagnetic storage technologies, or electronic storage technologies. Display interface 410 is adapted to produce video signals, which include the image which represents the selected implementation (game, simulation, and the like) together with the patterns, according to embodiments of the present invention. It is noted that display interface 410 is selected according to the specifications of display device 412, being digital or analog. Display device 412 can include any light projection screen, which emits light either in the visible wavelength range, outside of the visible wavelength range, or both. It is noted that the production of light in non-visible wavelengths, enables system 400 to produce non-visible patterns, which do not disrupt the visible image, presented to the users.

Receiver 402 is connected to demodulator 404. Processor 406 is connected to demodulator 404, storage unit 406, and to display interface 410. Display interface 410 is further connected to display device 412.

Processor 406 determines an application image, and provides an image display command to the display device 412, via display interface 410. In addition, the processor 406 determines a plurality of patterns, provides them to, and combines them with display device 412, via display interface 410. These patterns are combined with the already produced application image. It is noted that the processor 406 can dynamically change the application image, so that it appears as a live clip.

Receiver 402 detects signals, which are produced by at least one object, placed over display device 412. These signals can include embedded data. The demodulator 404 extracts any such data, and provides it to the processor 406, which in turn determines the location of the transmitting device and repeats the process.

It will be appreciated by persons skilled in the art, that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims, which follow.

CLAIMS

1. A method for automatic location of at least one object located on a surface, said surface being able to display patterns, said method comprising:

producing at least one pattern having a first content at a selected first location on said surface,

detecting said pattern at said object if said selected location coincides with the location of said object,

transmitting a signal indicative of detection of said pattern, and

utilizing said detected signal to identify the location of said object.

2. A method according to claim 1, wherein further patterns having said first content are displayed at successive further locations over said surface, such that the timing of the detection of the pattern is indicative of the location.

3. A method according to claim 1, wherein further patterns having further contents differing from said first content are displayed at different locations such that the content of the pattern is indicative of the location.

4. A method according to claim 1, wherein said signal comprises identification information of said object.

5. A method according to claim 2, wherein said signal comprises identification information of said object.

6. A method according to claim 3, wherein said signal comprises identification information of said object.

7. A method according to claim 3, wherein said signal comprises information indicative of said content.

8. A method according to claim 2, wherein said signal comprises data in pulsed format.

9. A method according to claim 1, comprising producing further patterns at further preselected locations such that said surface is scanned by a series of patterns in a scanning cycle.

10. A method according to claim 9, wherein said surface is scanned in a systematic manner.

11. A method according to claim 9, wherein said surface is scanned in a random order.

12. A method according to claim 9, said object being dimensioned such that it detects more than one pattern from each scanning cycle, and wherein information of said detected more than one pattern is used to indicate the orientation of said object.

13. A method according to claim 9, wherein said object has a first sensor for detecting patterns at a first location thereon, and a second sensor for detecting patterns at a second location thereon, wherein said first sensor detects a first pattern from said scanning cycle and said second sensor detects a second pattern from said scanning cycle, each sensor separately transmitting a signal indicative of said respective detected pattern and comprising an identification code of said sensor, thereby allowing the orientation of said object on said surface to be determined.

14. A method according to claim 1, wherein said object detects the relative orientation of said at least one pattern, and which embeds in said signal, information indicative of said orientation.

15. A method according to claim 1, wherein said at least one pattern comprises a plurality of pixels.

16. A method according to claim 5, comprising causing each one of said plurality of pixels to blink in a sequence.

17. A method according to claim 16 wherein each one of said plurality of pixels blinks in a different sequence.

18. A method according to claim 1, comprising the further step of illuminating the determined location of said object with high intensity light so as to assist said object to recharge itself.

19. A method according to claim 9, wherein said series of patterns define a series of concentric circles around a center.

20. A method according to claim 19, wherein said center is a previously determined location of said object.

21. A method according to claim 19, wherein said center is a most recently determined location of said object.

22. A method according to claim 1, wherein said selected location is initially half of said surface, it being thus determined whether said object is located on said selected half or said remaining half, and comprising a further step of dividing said half of said surface on which said object is determined to be located into halves, again determining on which half said object is located and continuing until said object is located with a predetermined level of precision.

23. A method according to claim 1, wherein said step of transmitting is carried out using any one of a group comprising ultrasound, RF, and infrared signaling.

24. A method according to claim 1, comprising incorporating within said content an identifier of said object, and wherein only an object so identified carries out said step of transmitting.

25. A method according to claim 1, wherein said surface displays a game board upon which said at least one pattern is superimposed.

26. A method according to claim 1, wherein said surface comprises an image display operative to display images in sequential frames, wherein a majority of frames are devoted to displaying a game board and in which said at least one pattern is displayed in at least one remaining frame.

27. A method according to claim 25, wherein said at least one pattern is comprised of radiation substantially outside of the visible spectrum.

28. A method according to claim 1, comprising the further step of receiving human input.

29. A method according to claim 1, comprising the further step of embedding a command in said at least one pattern, said object being operable to react to said command.

30. A system for automatic location of at least one object on a surface, said surface being able to display patterns, said system comprising:

a pattern generator for producing at least one pattern having a first content at a selected first location on said surface,

a first pattern detector mounted on said object for detecting said pattern at said object if said selected location coincides with the location of said object,

a transmitter mounted on said object for transmitting a signal indicative of detection of said pattern, and

a controller operable to receive said signal and to utilize said signal to identify the location of said object.

31. A system according to claim 30, wherein said pattern generator is further operable to generate patterns having said first content at further locations at successive times over said surface, such that the timing of the detection of one of said patterns by said object is indicative of the location of said object.

32. A system according to claim 30, wherein said pattern generator is further operable to generate patterns having further contents differing from said first content at different locations such that the content of the pattern is indicative of a location on said surface.

33. A system according to claim 30, wherein said object is operable to embed, in said signal, identification information of said object.

34 A system according to claim 31, wherein said object is operable to embed, in said signal, identification information of said object.

35. A system according to claim 32, wherein said object is operable to embed, in said signal, identification information of said object.

36. A system according to claim 32, wherein said object is operable to embed, in said signal, information indicative of said content.

37. A system according to claim 32, wherein said transmitter comprises a modulator, said modulator being adapted to modulate said signal into a pulsed format.

38. A system according to claim 30, wherein said pattern generator is adapted to generate patterns at further preselected locations such that said surface is scanned by a series of patterns in a scanning cycle.

39. A system according to claim 38, wherein said pattern generator is adapted to scan said surface in a systematic manner.

40. A system according to claim 38, wherein said pattern generator is adapted to scan said surface in a random order.

41. A system according to claim 38, wherein said first pattern detector is located at a first location on said object, and a second pattern detector is located at a second location thereon, such that said first pattern detector is operative to detect a first pattern from said scanning cycle and said second pattern detector is operative to detect a second pattern from said scanning cycle, each pattern detector separately being adapted to transmit a signal indicative of said respective detected pattern and comprising an identification code of said pattern detector, thereby allowing the orientation of said object on said surface to be determined.

42. A system according to claim 30, said object being adapted to detect the relative orientation of said at least one pattern, and being adapted to embed in said signal, information indicative of said orientation.

43. A system according to claim 30, wherein said at least one pattern comprises a plurality of pixels.

44. A system according to claim 43, said pattern generator being adapted to control each one of said plurality of pixels to blink in a sequence.

45. A system according to claim 44, said pattern generator being adapted to control each one of said plurality of pixels to blink in a different sequence.

46. A system according to claim 30, further comprising a high intensity light source positioned to shine at the determined location of said object, and

wherein the object comprises a transducer for converting light from said light source into energy to for powering said object.

47. A system according to claim 37, wherein said pattern generator is adapted to produce said pattern as a series of concentric circles around a center.

48. A system according to claim 47, wherein said center is a previously determined location of said object.

49. A system according to claim 47, wherein said center is a most recently determined location of said object.

50. A system according to claim 30 wherein said transmitter is any one of a group comprising an ultrasound, an RF, and an infrared transmitter.

51. A system according to claim 30, wherein an identifier of said object is incorporated within said content, wherein said object comprises identifier circuitry to recognize said identifier and is operative to transmit a signal only said identifier is recognized.

52. A system according to claim 30, said surface being adapted to display a game board upon which said at least one pattern is superimposed.

53. A system according to claim 30, wherein said surface comprises an image display operative to display images in sequential frames, wherein a majority of frames are devotable to displaying a game board and in which said at least one pattern is displayable in at least one remaining frame.

54. A system according to claim 52, wherein said surface is adapted such that said at least one pattern is comprisable of radiation substantially outside of the visible spectrum.

55. A system according to claim 30, further comprising at least one input device adapted for receiving human input.

56. A system according to claim 30, wherein a command is embeddable in said at least one pattern, said object comprising command identification circuitry to identify said command and response circuitry able to control said object to carry out a response action.

57. A system according to claim 30, wherein at least said first pattern detector is any one of a group comprising a photoelectric detector, a photoelectric cell, a charge-coupled device, an array of photoelectric detectors, an array of photoelectric cells, and an array of charge-coupled devices.

58. A system according to claim 30, further comprising an actuator for moving said object.

59. An object, to be moved over a surface, having a base for maintaining contact with said surface and a radiation detector located in said base, the object further comprising a signal generator for generating a signal in response to an output of said radiation detector, and a transmitter for transmitting said signal.

60. An object according to claim 59, wherein said radiation detector is any one of a group comprising a photoelectric detector, a photoelectric cell, a charge-coupled device, an array of photoelectric detectors, an array of photoelectric cells, and an array of charge-coupled devices.

61. An object according to claim 59, said signal generator further being operable to embed in said signal identification information of said object.

62. An object according to claim 59, said signal generator further being operable to embed, in said signal, data indicative of a content of a pattern detected by said radiation detector.

63. An object according to claim 59, comprising a further radiation detector, each radiation detector being placed on different locations on said base such that detected radiation from each radiation detector can be compared to provide an indication of the orientation of said object with respect to said surface.

64. An object according to claim 63, wherein said signal generator further comprises circuitry for embedding in said signal, information of said orientation indication.

65. An object according to claim 59, wherein said radiation detector is a photoelectric cell and wherein circuitry is provided for using the output of said photoelectric cell to provide power for said object.

66. An object according to claim 59, wherein said transmitter is any one of a group comprising an R.F. transmitter, an ultrasonic transmitter and an infrared transmitter.

67. An object according to claim 59, further comprising an actuator for moving said object.

68. An object according to claim 67, wherein said actuator is operable to move said object in response to commands embedded in said detected radiation.

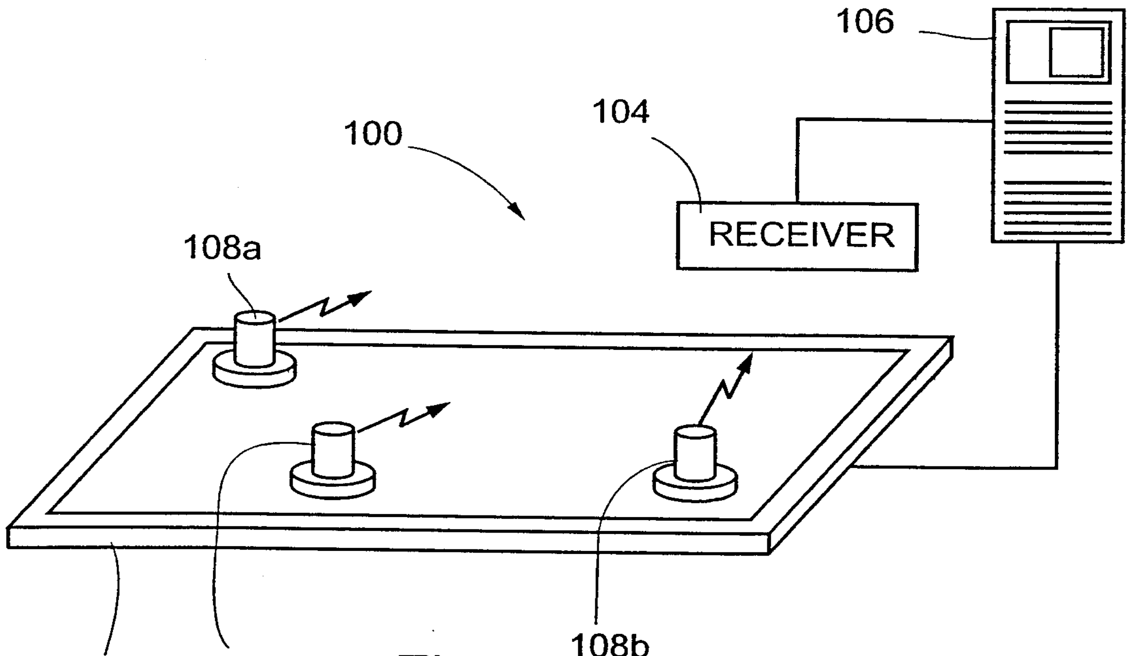
106
104
100
RECEIVER
108a
102
108c
108b

Fig. 1

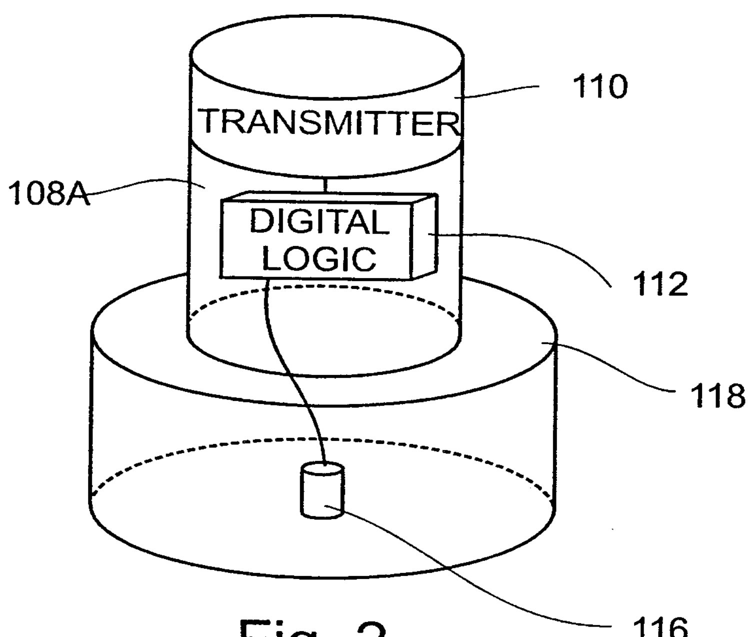
110
TRANSMITTER
108A
DIGITAL
LOGIC
112
118
116

Fig. 2

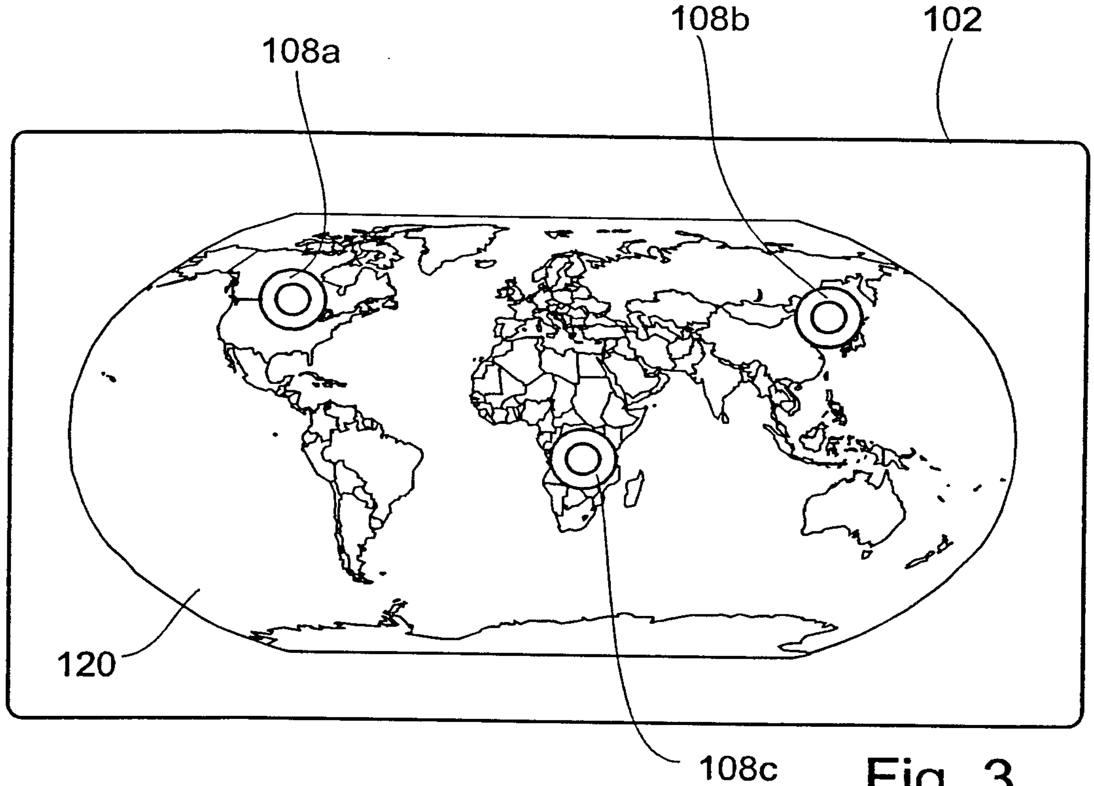

Fig. 3

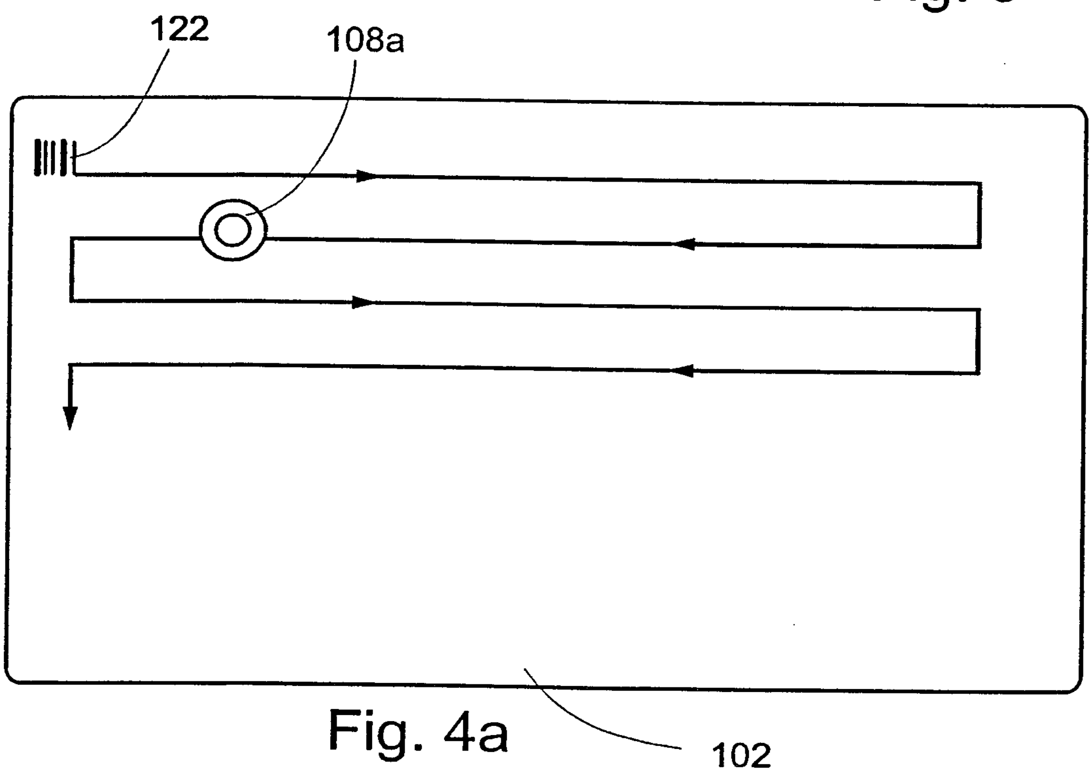

Fig. 4a

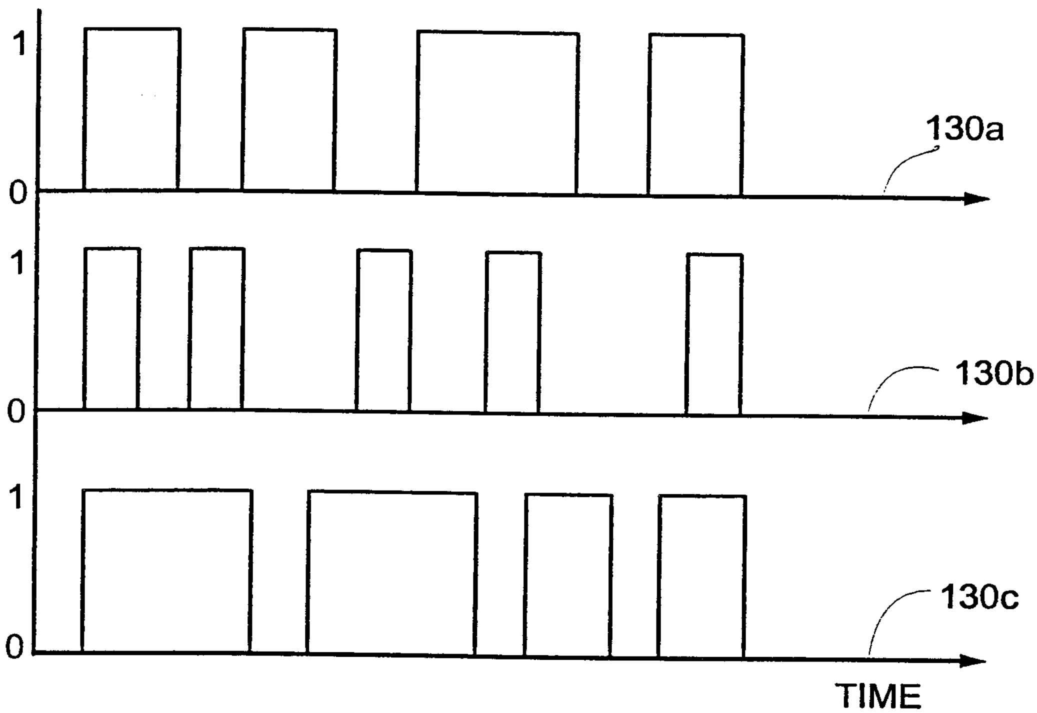

Fig. 4b

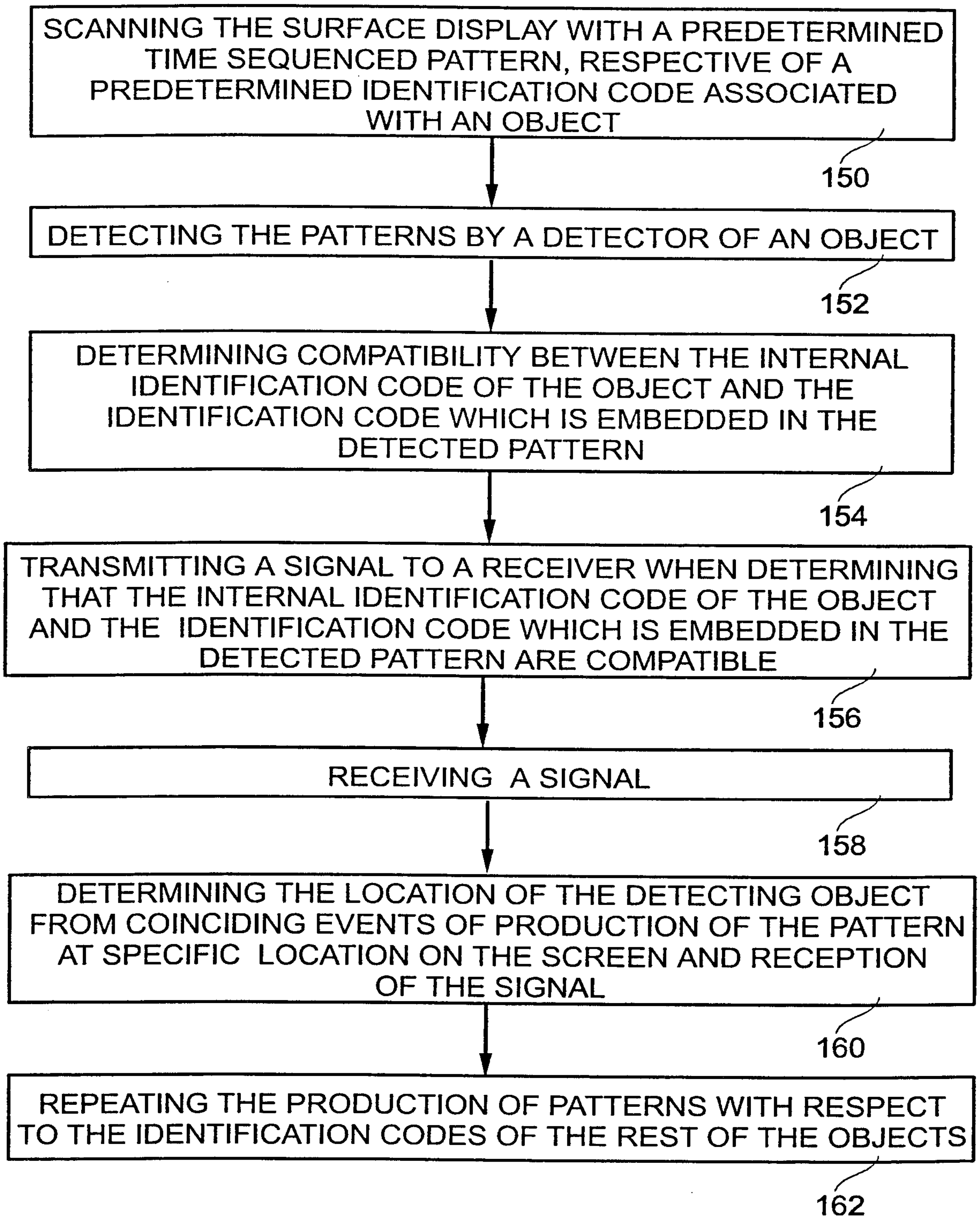
SCANNING THE SURFACE DISPLAY WITH A PREDETERMINED TIME SEQUENCED PATTERN, RESPECTIVE OF A PREDETERMINED IDENTIFICATION CODE ASSOCIATED WITH AN OBJECT
150
DETECTING THE PATTERNS BY A DETECTOR OF AN OBJECT
152
DETERMINING COMPATIBILITY BETWEEN THE INTERNAL IDENTIFICATION CODE OF THE OBJECT AND THE IDENTIFICATION CODE WHICH IS EMBEDDED IN THE DETECTED PATTERN
154
TRANSMITTING A SIGNAL TO A RECEIVER WHEN DETERMINING THAT THE INTERNAL IDENTIFICATION CODE OF THE OBJECT AND THE IDENTIFICATION CODE WHICH IS EMBEDDED IN THE DETECTED PATTERN ARE COMPATIBLE
156
RECEIVING A SIGNAL
158
DETERMINING THE LOCATION OF THE DETECTING OBJECT FROM COINCIDING EVENTS OF PRODUCTION OF THE PATTERN AT SPECIFIC LOCATION ON THE SCREEN AND RECEPTION OF THE SIGNAL
160
REPEATING THE PRODUCTION OF PATTERNS WITH RESPECT TO THE IDENTIFICATION CODES OF THE REST OF THE OBJECTS
162

Fig. 5

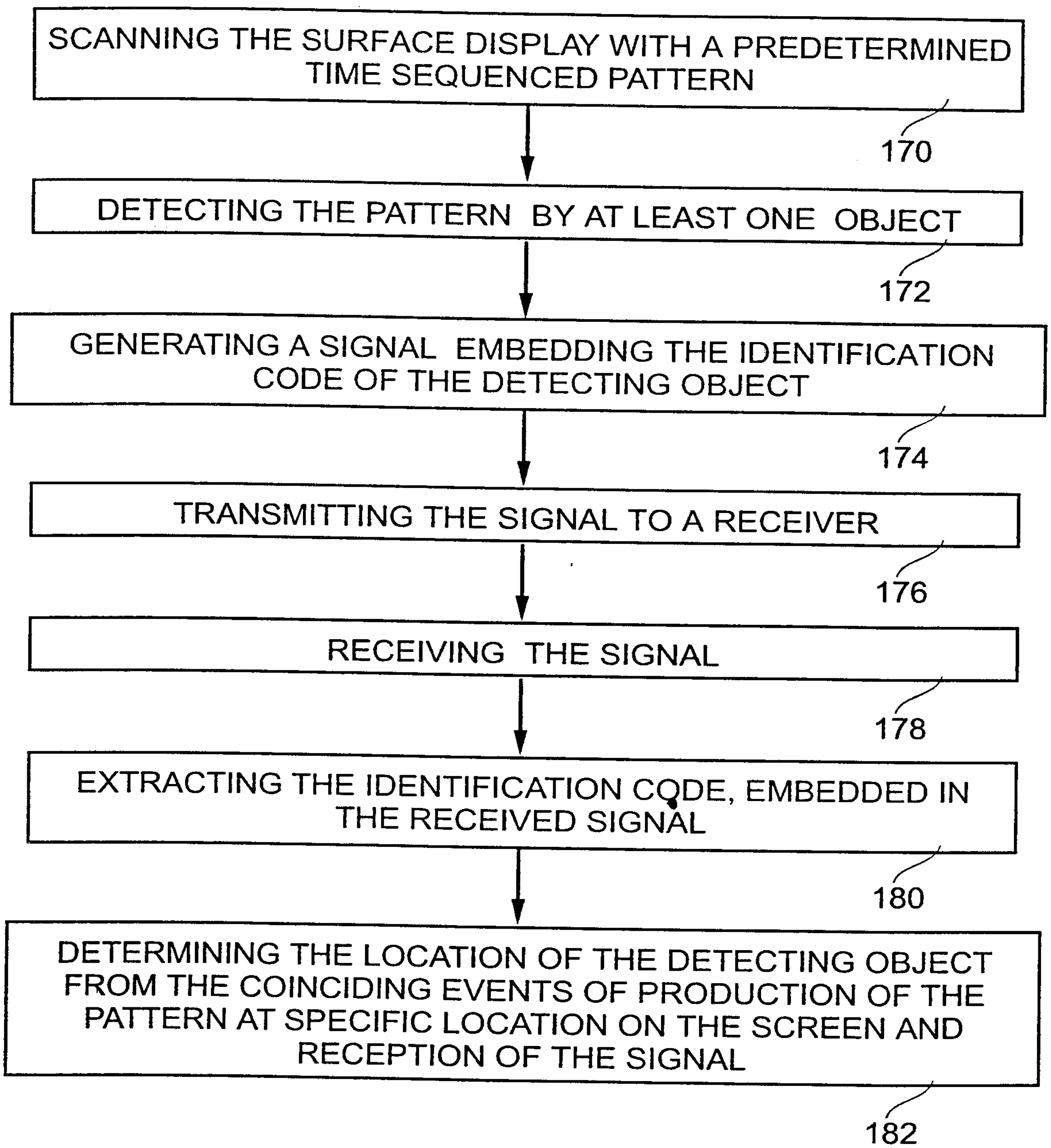
SCANNING THE SURFACE DISPLAY WITH A PREDETERMINED TIME SEQUENCED PATTERN
170
DETECTING THE PATTERN BY AT LEAST ONE OBJECT
172
GENERATING A SIGNAL EMBEDDING THE IDENTIFICATION CODE OF THE DETECTING OBJECT
174
TRANSMITTING THE SIGNAL TO A RECEIVER
176
RECEIVING THE SIGNAL
178
EXTRACTING THE IDENTIFICATION CODE, EMBEDDED IN THE RECEIVED SIGNAL
180
DETERMINING THE LOCATION OF THE DETECTING OBJECT FROM THE COINCIDING EVENTS OF PRODUCTION OF THE PATTERN AT SPECIFIC LOCATION ON THE SCREEN AND RECEPTION OF THE SIGNAL
182

Fig. 6

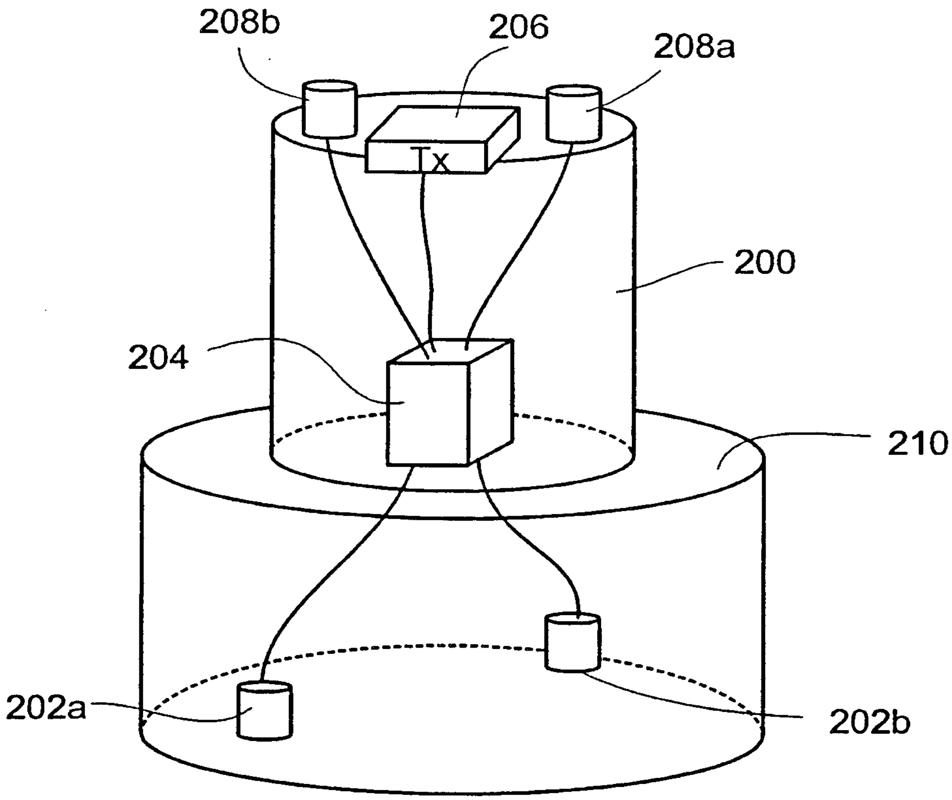
208b
206
208a
Tx
200
204
210
202a
202b

Fig. 7a

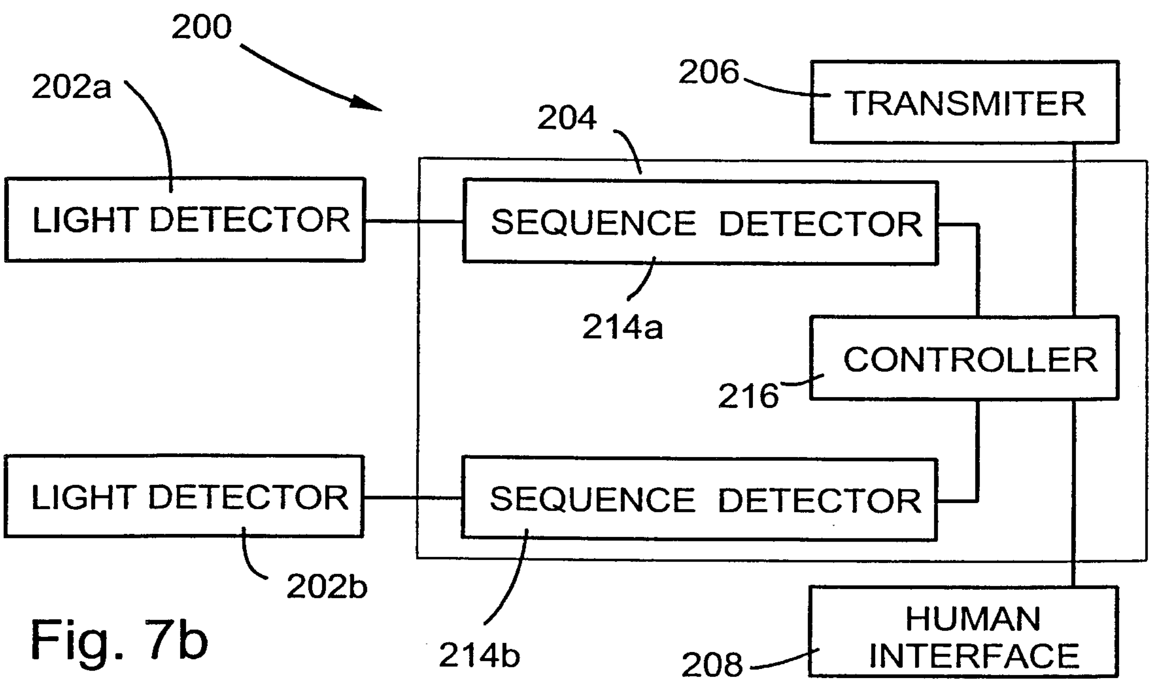
200
202a
206
TRANSMITER
204
LIGHT DETECTOR
SEQUENCE DETECTOR
214a
CONTROLLER
216
LIGHT DETECTOR
SEQUENCE DETECTOR
202b
214b
208
HUMAN INTERFACE

Fig. 7b

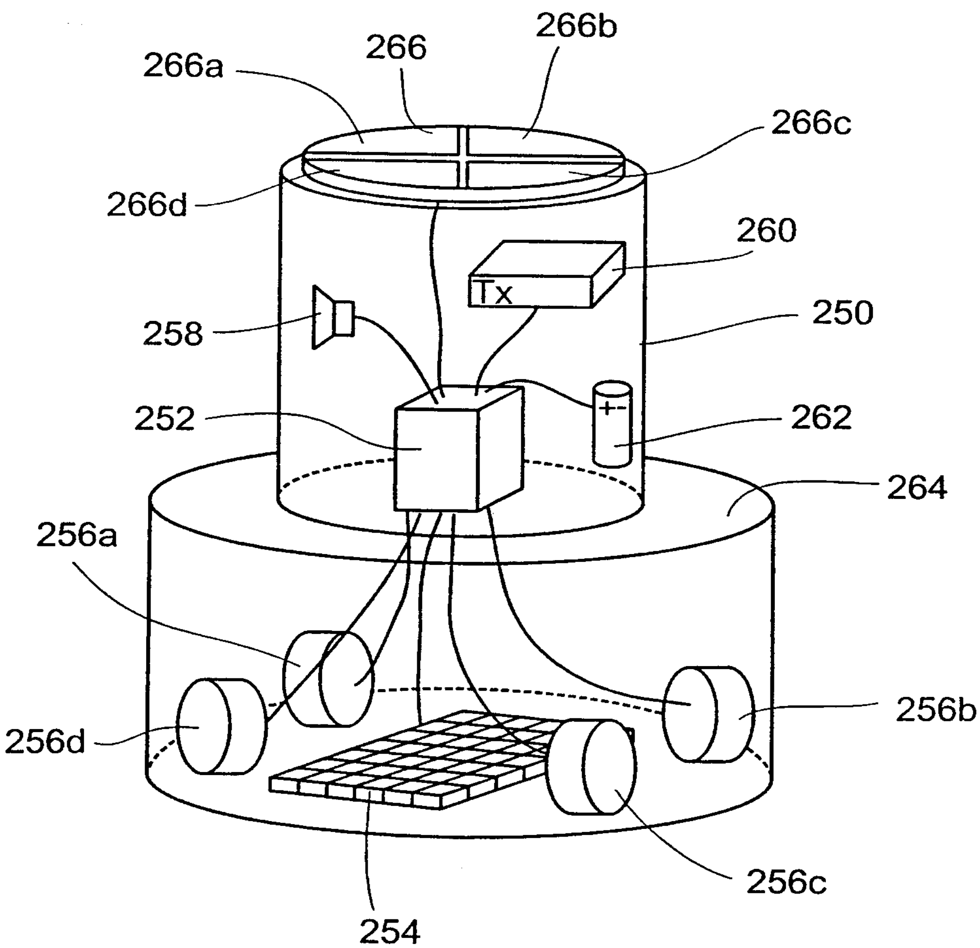
266a
266
266b
266c
266d
260
Tx
258
250
252
262
264
256a
256b
256d
256c
254

Fig. 8

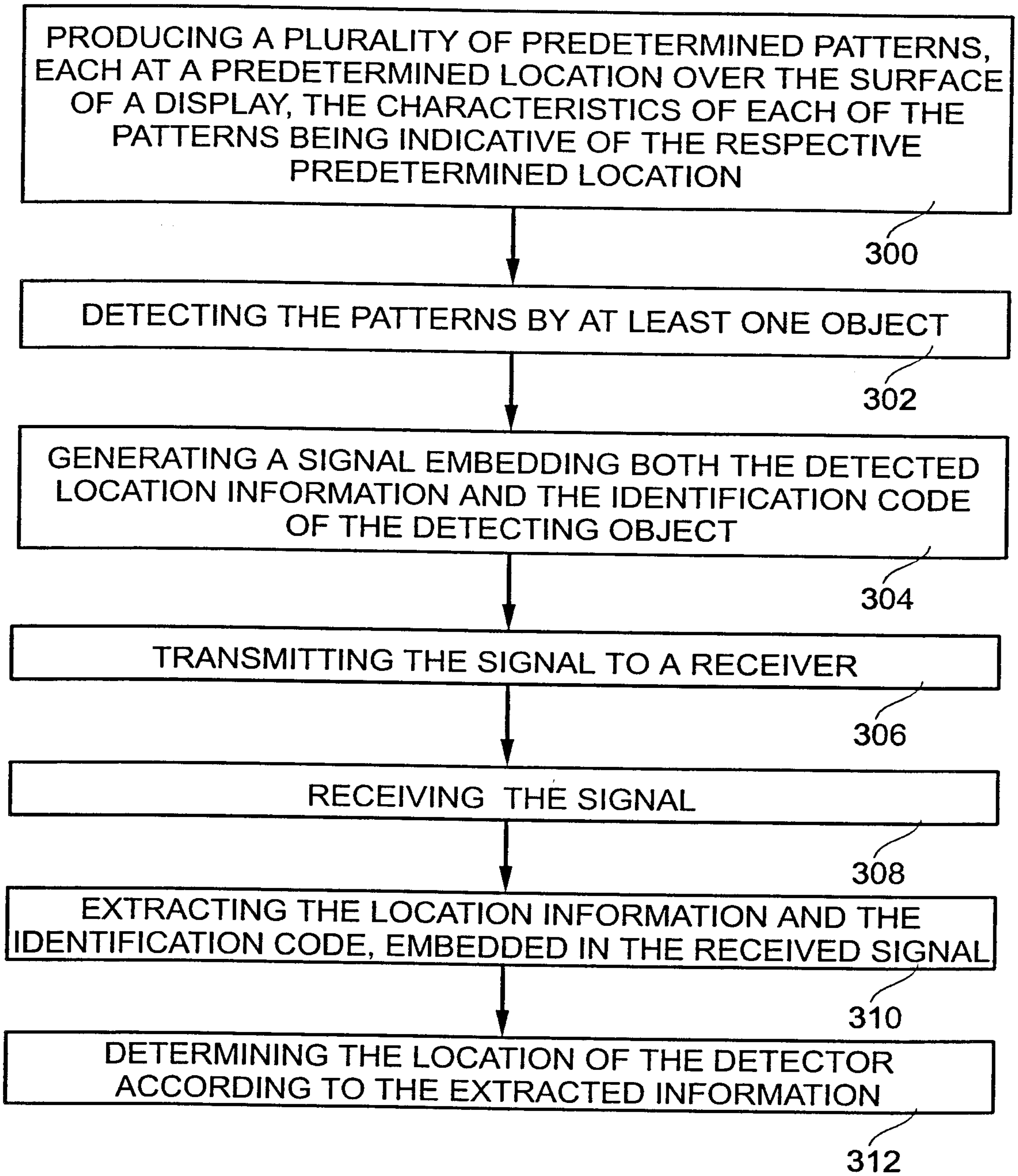
PRODUCING A PLURALITY OF PREDETERMINED PATTERNS, EACH AT A PREDETERMINED LOCATION OVER THE SURFACE OF A DISPLAY, THE CHARACTERISTICS OF EACH OF THE PATTERNS BEING INDICATIVE OF THE RESPECTIVE PREDETERMINED LOCATION
300
DETECTING THE PATTERNS BY AT LEAST ONE OBJECT
302
GENERATING A SIGNAL EMBEDDING BOTH THE DETECTED LOCATION INFORMATION AND THE IDENTIFICATION CODE OF THE DETECTING OBJECT
304
TRANSMITTING THE SIGNAL TO A RECEIVER
306
RECEIVING THE SIGNAL
308
EXTRACTING THE LOCATION INFORMATION AND THE IDENTIFICATION CODE, EMBEDDED IN THE RECEIVED SIGNAL
310
DETERMINING THE LOCATION OF THE DETECTOR ACCORDING TO THE EXTRACTED INFORMATION
312

Fig. 9

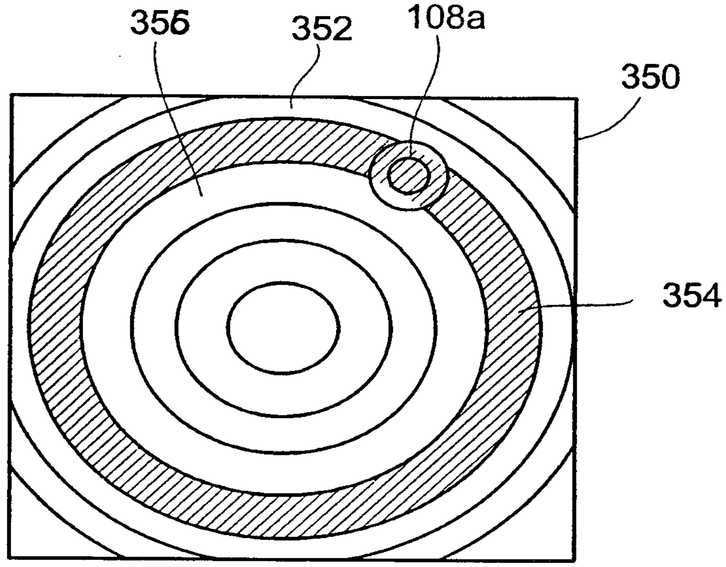

Fig. 10a

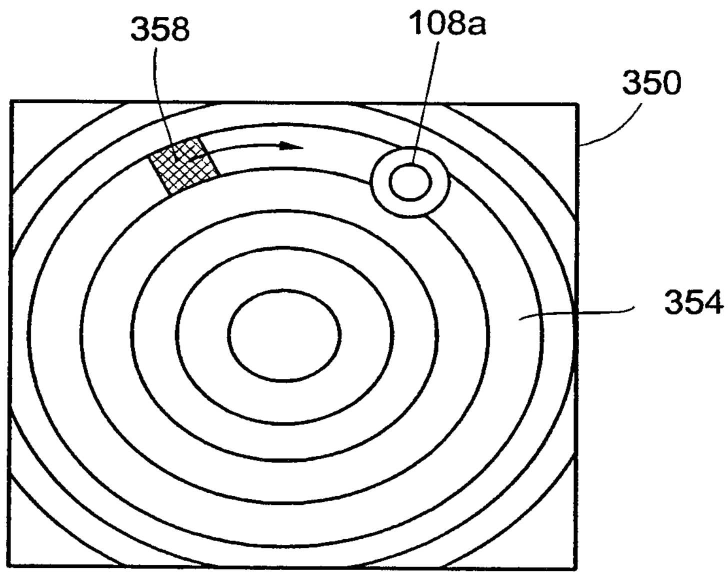

Fig. 10b

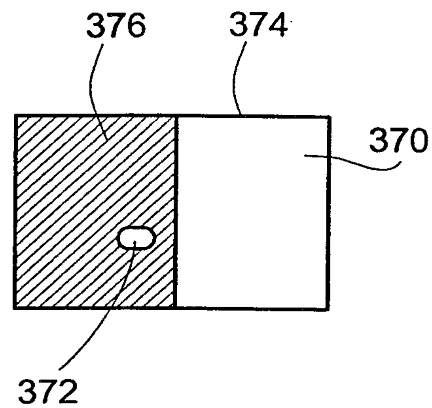

Fig. 11a

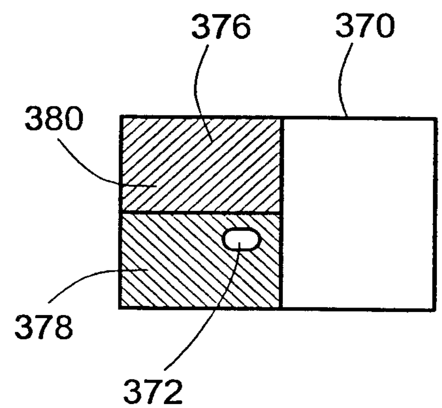

Fig. 11b

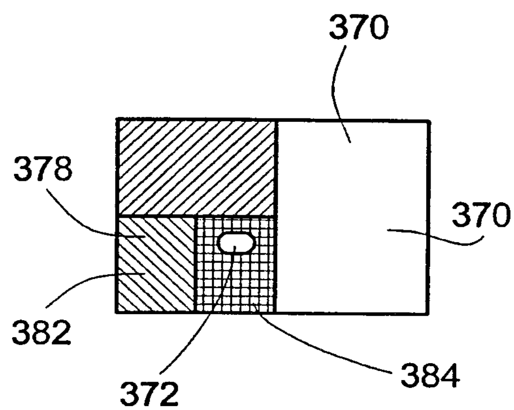

Fig. 11c

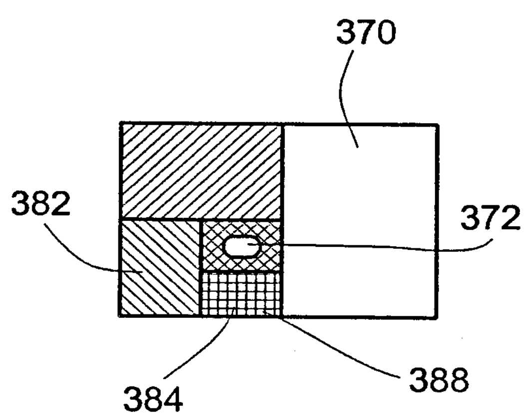

Fig. 11d

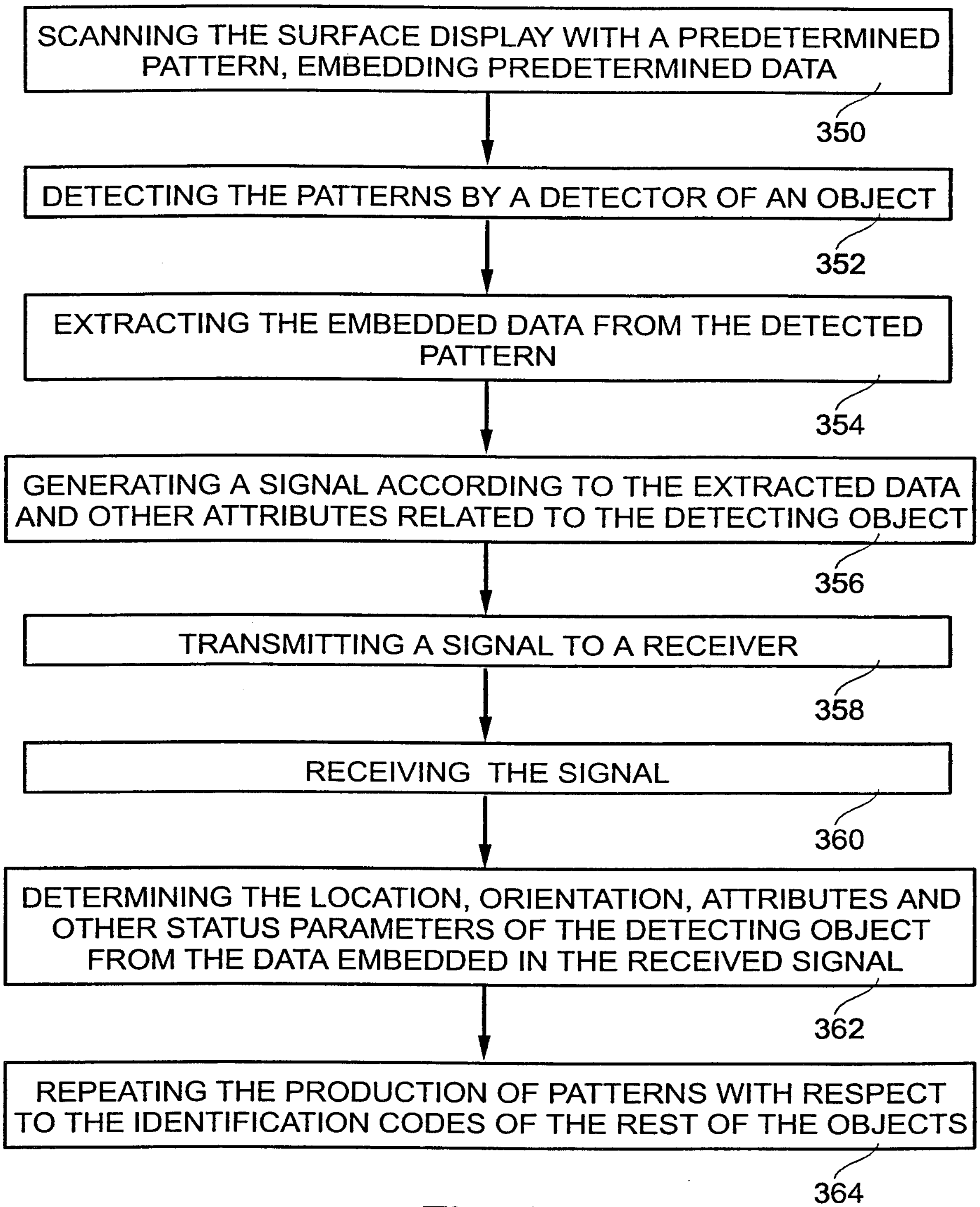
SCANNING THE SURFACE DISPLAY WITH A PREDETERMINED PATTERN, EMBEDDING PREDETERMINED DATA
350
DETECTING THE PATTERNS BY A DETECTOR OF AN OBJECT
352
EXTRACTING THE EMBEDDED DATA FROM THE DETECTED PATTERN
354
GENERATING A SIGNAL ACCORDING TO THE EXTRACTED DATA AND OTHER ATTRIBUTES RELATED TO THE DETECTING OBJECT
356
TRANSMITTING A SIGNAL TO A RECEIVER
358
RECEIVING THE SIGNAL
360
DETERMINING THE LOCATION, ORIENTATION, ATTRIBUTES AND OTHER STATUS PARAMETERS OF THE DETECTING OBJECT FROM THE DATA EMBEDDED IN THE RECEIVED SIGNAL
362
REPEATING THE PRODUCTION OF PATTERNS WITH RESPECT TO THE IDENTIFICATION CODES OF THE REST OF THE OBJECTS
364

Fig. 12

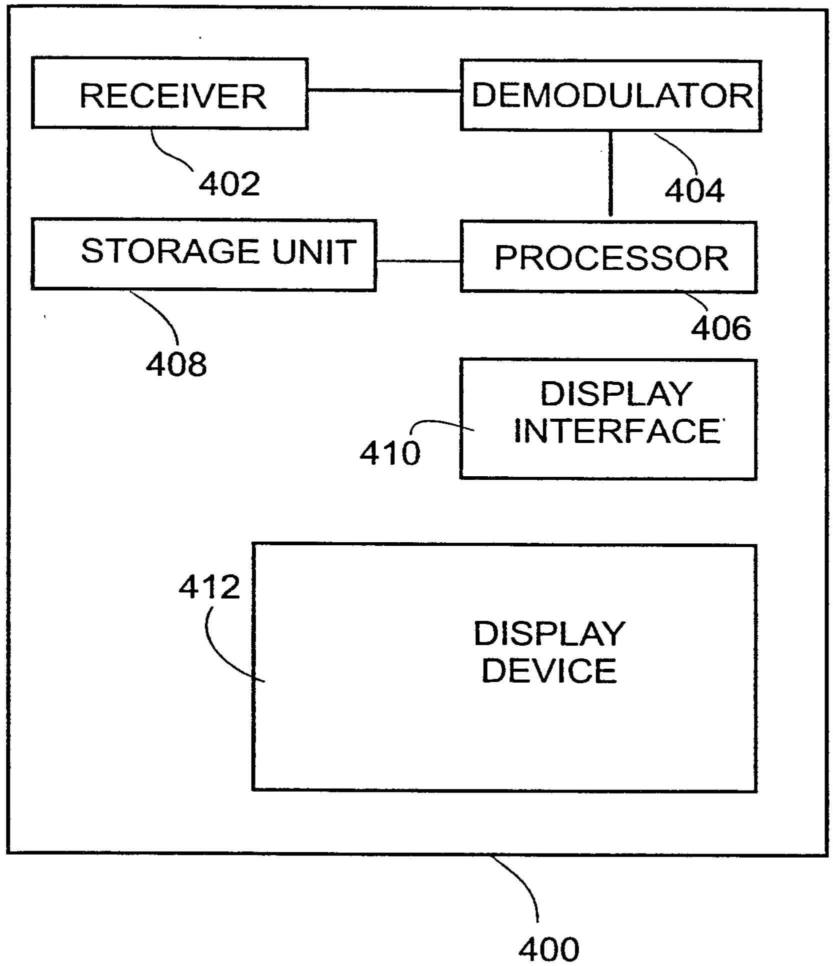
RECEIVER
DEMODULATOR
402
404
STORAGE UNIT
PROCESSOR
406
408
DISPLAY INTERFACE
410
412
DISPLAY DEVICE
400

Fig. 13